DEMOGRAPHIC ASYMMETRY OF A REGION: A LOCAL ANALYSIS USING SPATIAL ECONOMETRICS

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Abstract

Demographic asymmetry is a process of unequal reproduction of human capital in different territories of the region, provided by the uneven dynamics of demographic processes (birth, mortality, migration) and the development of appropriate infrastructure (health, education, culture, etc.). Prompt detecting and regular monitoring unevenness of demographic dynamics is a key for the deliberate government decisions to improve life quality. In this regard, assessing regional demographic asymmetry is of great scientific interest. The paper presents using spatial econometric indicators such as *Global Moran's I* and *Local Moran's I* to detect the regional demographic asymmetry. Testing demographic data of Sverdlovskiy region (Russia) in 2019, the author examines if there are some clusters of municipalities having common trends of demographic development and being the special point in the regional map. The results of the demographic asymmetry research are following. (1) The demographic indicators of municipalities in Sverdlovskiy region have a positive spatial autocorrelation, thus there are some clusters of territories having significant difference of demographic development. (2) The specified clusters are in common with current settlement system and economic development level; thus, the research results are meaningful for developing regional social and economic policy and monitoring its performance.

Key words: demographic asymmetry, municipality, region, spatial autocorrelation

JEL Code: J11, R12

Introduction

The demographic dynamics of a region has the growing disparities due to both the peculiarities of the socio-economic development of individual municipality and the development of the territorial settlement system as a whole. Thus, we should to understand the esence and consequences of demographic asymmetry to create the appropriate policy for improving the life quality of population regardless of the place of residence (central city or small village).

A fairly wide range of studies is devoted to the assess the asymmetry of territorial development both in Russia (Kondusova & Bahtina, 2019; Pavlov & Koroleva, 2014; Manaeva, 2019) and other countries (Manesh et al., 2020; Spijker et al., 2020; Mansour et al., 2020) employing the methods of normative, indicative and comparative analysis. It is the latter that opens up the wide opportunities for the researcher to choose any indicators and methods. Also the comparative analysis increases the confidence of the obtained results due to availability of statistical data and well-developed evaluation algorithms.

This paper presents a piece of the research results. Previously, we have determined that demographic asymmetry is, on the one hand, the process of asymmetric reproduction of human capital in different territories of the region; and, on the other, it is the result of the population placement in the regional space formed under the various forces (Makarova & Trushkova, 2020). In this case, the population size dynamics is the resulting indicator: the well-off territories are characterized by population growth, the unfavorable ones have its decline, and comparison of such changes reflects the demographic asymmetry.

At the same time, a specific research interest is more then just comparing the population change rates in different municipalities, it also concerns to assess the mutual influence of the demographic development of different territories (birth and mortality rates) and to eliminate the stable spatial relationships. In this regard, the purpose of this paper is to assess the demographic asymmetry of the region using the methods of spatial econometrics (in particular, the Moran method) on the example of the Sverdlovskiy region (Russia).

1 Data and Methods

1.1 Data

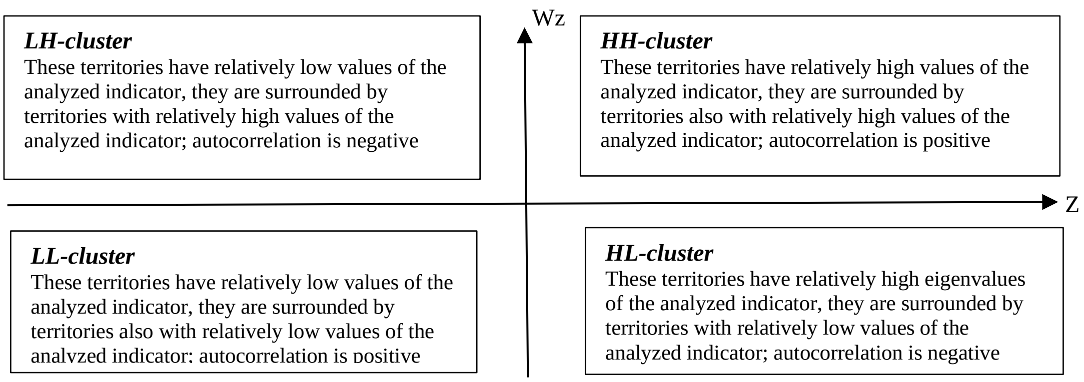
Demographic data (birth, mortality, natural increase) are the objective indicators to assess a socio-demographic asymmetry as a result of settlement processes. It forms the fairly series at the municipal level, which allows us to search for patterns in the spatial distribution of the population and its dynamics using mathematical methods. In this regard, the study uses the population indicator of the municipalities of the Sverdlovsk region for 2019, on the basis of which the local and global Moran indices are calculated. The weight matrix is formed on the basis of the distances between the central localities of municipalities, calculated by roads according to the data of specialized sites such as Yandex.Maps.

1.2 Methods

Demographic asymmetry reflects the spatial heterogeneity of the region's settlement system, thus we use the spatial econometrics methods (Anselin, 1988) to visualize the unevenness of spatial development and to clusterize the similar and different territories. We explore the Moran method (Moran, 1948; Pavlov & Koroleva, 2014) to determine the spatial autocorrelation, to categorize the municipalities and to establish any interactions among the studied territoties.

The *Global Moran's I* allows to assess the presence or absence of spatial autocorrelation between the values of an indicator for the neighboring territories. *Local Moran's I* (*LISA*) is calculated for each territory separately and allow to assess the presence or absence of spatial autocorrelation of a particular territory with the neighboring territories. In additon, a Moran's scattering diagram is constructed, where the *z*-standardized values of the indicators (*LISA*) are plotted along the horizontal axis, and the values of the spatial vector *Wz* (built on the weight matrix) are plotted along the vertical axis. To be more precise, we restricted the set of *LISAs* using just $LISA_i > LISA_{average}$. Thus, the territories are clustered in four quadrants, characterized by different qualitative parameters (Fig. 1).

Fig 1: Clusters of territories according to Moran's scattering diagram



2 Results and Discussion

Sverdlovskiy region (Russia) has 69 municipalities. In 2019, its population reaches 4.31 million people, birth rate is 10.7‰, mortality rate is 13.4‰, and thus natural increase of population is -2.7‰. Based on the data of demographic indicators for all municipalities in the region, we counted *IG* and *EI* (tab. 1).

Table 1 shows, that *IG* is more than *EI* and *z*-statistic is significant at α=0.05, so the demographic indicators of the municipalities are correlated positively. It means that the neighboring territories have the statistically significant differences in values of demographic indicators, and this is the demographic asymmetry in the region. Thus, there are some clusters of territories having significant difference of demographic development.

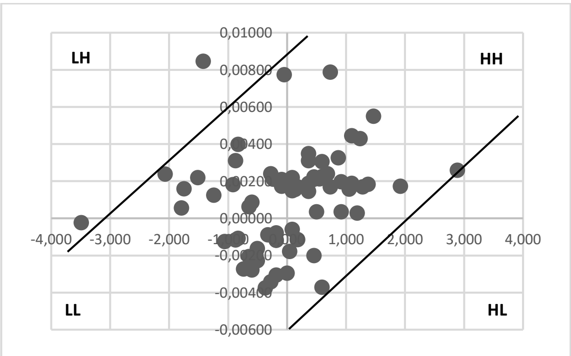
Tab. 1: Global Moran's I of Sverdlovsk region in 2019

Indicator	*IG*	*EI*	Spatial autocorrelation	*z*-statistic
Birth rate	0.0389	-0.0147	positive	20.17*
Mortality rate	0.0625	-0.0147	positive	23.71*
Natural increase rate	0.2044	-0.0147	positive	30.44*
Total population increase rate	0.0998	-0.0147	positive	16.32*

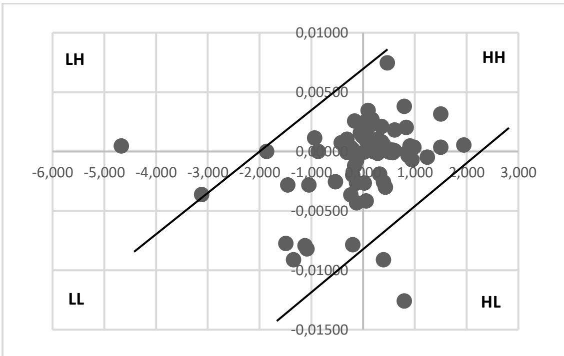
Source: Author's calculations

Fig. 2 demonstrates the scattering diagrams for the indicators under the research, and the positive spatial correlation is obvious.

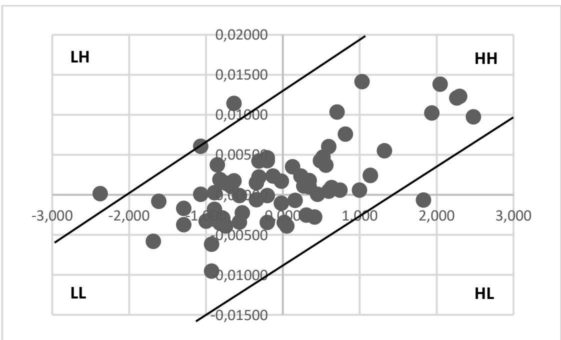
Fig 2: Moran's scattering diagrams for demographic indicators of Sverdlovskiy region municipalities in 2019



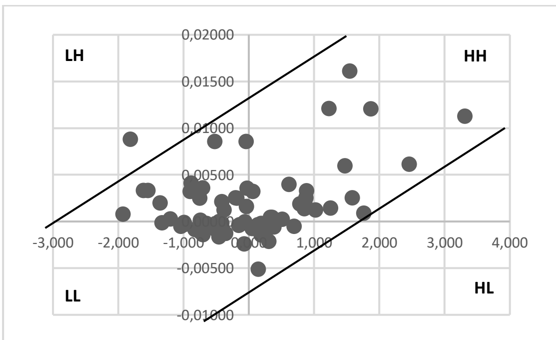
a) birth rates



b) mortality rates



c) natural increase rates



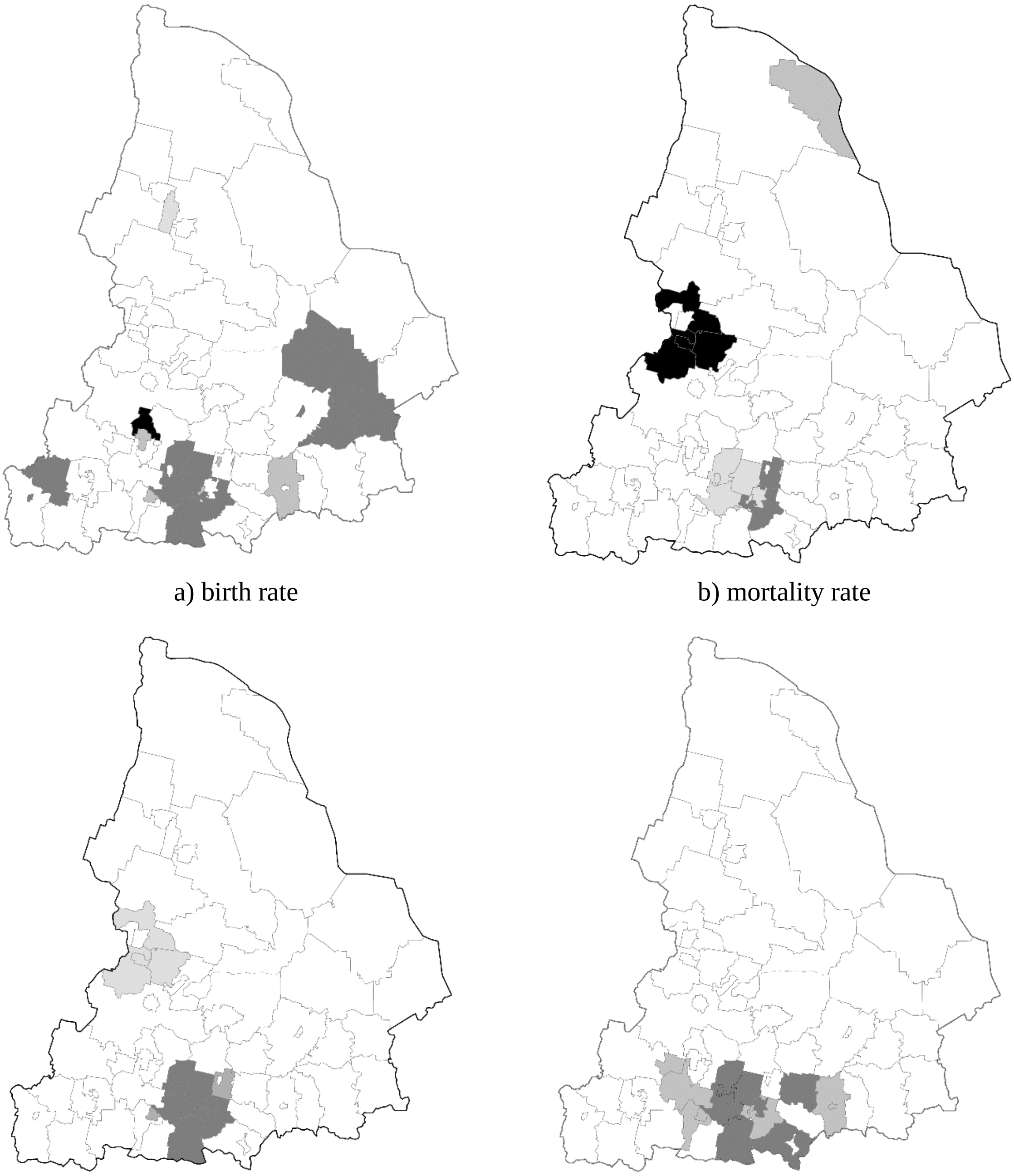
d) total population increase rates

* At α=0.05 it allows to reject the null hypothesis that the observed spatial model has a structural pattern of theoretical random mode

Source: Author’s calculations

Using criteria $LISA_i > LISA_{average}$, we created a pool of the maps where significant clusters of territories are colored differently: high-high cluster (HH) is black; high-low cluster (HL) is dark grey; low-high cluster (LH) is grey; low-low cluster (LL) is light grey. Fig. 3 displays these clusters of the significant *LISAs* for each indicator.

Fig. 3: Moran’s distribution clusters of Sverdlovskiy region municipalities in 2019



a) birth rate

b) mortality rate

c) natural increase rate

d) total population increase rate

Source: Author’s calculations

Fig. 3 highlights that the south municipalities around the major city accumulate the remarkable demographic dynamics due to the intensive agglomeration building. These territories aggrigate the birth rates of high-low mode (Fig. 3a) and th mortality rates of low-low and high-low mode (Fig. 3b). Thus, these municiplities create a point of demographic growth of the region both in terms of natural increase rate and total population increase rate (Fig. 3c, 3d).

The eastern and nothern municipalities accumulate the negative demographic dynamics such as the mortality rates of high-high and high-low mode (Fig. 3b) and the natural increase rates of low-low mode (Fig. 3c). Despite the given gaps, these territories do not have a significance for the total population change in terms of a whole region (Fig. 3d).

The results reflect the specifics of the regional settlement system that is so-called cluster settlement, where the demographic dynamics is concentrated in major city, and there are dips between the points of population concentration around the major city on the south and around middle-sized citiy on the west. In addition, just the major city and its agglomeration construct the demographic point of growth. On contrary, the western point is the one of degradation; and so do the notheren territories in terms of the particular indicators.

Conclusion

The paper presents a piece of researching the demographic asymmetry of a region. Using the spatial econometrics methods such as *Global Moran's I* and *Local Moran's I* for the analysis of the settlement system of the Sverdlovskiy region (Russia), we proved the presence of demographic asymmetry in the form of spatial autocorrelation of the demographic indicators of the municipalities in the region.

We found0u900008s713 309ys4zun4c0 595.32 841.92 reW* nBT/F2 12 Tf1 0 0 1 70.824 384.43 Tm0

re12indicators of

of spatial demographic dynamics, to detect the problem to population existing and to weaken the negative effects of demographic asymmetry.

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References

Anselin, L. (1988). *Spatial Econometrics: Methods and Models*. Dordrecht: Kluwer Academic Publishers.

Kondusova, V., & Bahtina, V. (2019). Variation analysis of the labor market in the municipalities of the Orenburg region. *Intelligence. Innovation. Investment*, *3*, 27-35.

Makarova, M., & Trushkova E. (2020). Review of theoretical approaches to the study of socio-demographic asymmetry of territorial development. *Journal of Fundamental Research, 9*, 67-72. doi: 10.17513/fr.42846

Manaeva, I. (2019). Distribution of Cities in Federal Districts of Russia: Testing of the Zipf Law. *Economy of Region*, *15*(1), 84-98. doi: 10.17059/2019-1-7.

Manesh, S., Choi, J. Shrestha, B., Lim, J., & Sheresta, P. (2020). Spatial Analysis of the Gender Wage Gap in Architecture, Civil Engineering, and Construction Occupations in the United States, *Journal of Management in Engineering, 4,* №04020023. doi: 10.1061/(ASCE)ME.1943-5479.0000780

Mansour, Sh., Saleh, E., & Al-Awadhi T. (2020). The Effects of Sociodemographic Characteristics on Divorce Rates in Oman: Spatial Modeling of Marital Separations. *Professional Geographer*, *72*(3), 332-347. DOI: 10.1080/00330124.2020.1730196

Moran, P. (1948). The interpretation of statistical maps. *Journal of the Royal Statistical Society, 10,* 243-251.

Pavlov, Yu., & Koroleva, E. (2014). Spatial interactions: an estimate based on the global and local Moran index. *Spatial Economics, 3,* 95-110. doi: 10.14530/se.2014.3.95-110

Spijker, J., Recano, J. Martinez, S., & Carioli, A. (2020). Mortality by cause of death in Colombia: a local analysis using spatial econometrics. *Journal of Geographical Systems, August*. doi: 10.1007/s10109-020-00335-1

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